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Probing Electron Correlation with Sequential Laser-Induced Tunnel Ionization

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Since 1964 we have known that multiphoton ionization could be approximated by tunnel ionization for long wavelength light. Aside from re-collision, since then multiple ionization has been treated as successive, independent single ionization events. Our results show that this long-held belief is false. Tunnelling is highly directional and highly sensitive to the ionization potential (I_p) of the accessible ionic states (which itself can depend on the direction of ionization). Using rare gas atoms as examples, we show that laser induced tunnelling is suppressed or enhanced depending on how the field is applied. We image the hole left by the first tunnelling electron by measuring in the spatial correlation of the second electron. Laser induced tunnelling gives us experimental access to one of the most difficult to measure properties of matter – electron-electron correlations [1].

[1] A. Fleischer, H.J. Wörner, L. Arissian, L.R. Liu, M. Meckel, A. Rippert, R. Dörner, D.M. Villeneuve, A. Staudte and P.B. Corkum, unpublished results.